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XVI.—*On the Nidification of Crustacea.* By C. SPENCE BATE, F.L.S., Corr. Memb. of the Dublin University Zoological and Botanical Association*.

[With a Plate.]

THAT animals build nests, some for temporary and others for permanent occupation, is well known; but that any which dwell beneath the sea should do so, was not formerly supposed possible; and I believe that it is among the more recent of discovered facts that some species of Crustacea habitually dwell in abodes of their own construction.

The American naturalist, Say†, was the first who discovered one of the Amphipoda in a small tube which he believed it to occupy as a tenant, in the same way as the *Pagurus Bernhardus* takes possession of the shell of the Whelk, &c. The tube, which was cylindrical, membranaceous, diaphanous, and open at each end, Say thought to have been constructed by an Annelid which had either vacated or been driven from its home; the tube was then taken possession of by the Amphipod.

For this animal Say established the genus *Cerapus*, and named the species *tubularis*. He describes the animal as being very active, running with great facility amongst the branches of *Fucus*, *Sertularia*, &c., although encumbered by its tube, and, what he thought to be very extraordinary, made use of its four antennæ only as feet, the proper feet being all included within the tube, with the exception of the two anterior pairs (gnatho-

* Communicated by the author, having been read at the Plymouth Institution and Devon and Cornwall Natural History Society, on Feb. 1st, 1858.

† Trans. Philad. Soc. vol. i.

poda), which are used only to seize prey and convey it to the mouth.

“The tube is always proportioned to the size of the animal, and appears to invest it closely; nevertheless, when the animal is prevented from proceeding onwards, it turns its body immediately, protrudes its head from the opposite extremity, and thus makes use of either end indifferently as the anterior part.

“When swimming about, one-half of the body is projected from the tube, and is suddenly and repeatedly inflected, so as to proceed forwards by jerks.”

We thus perceive that Say was on the verge of a very interesting discovery in the habits of the small Crustacea, but, yielding to analogous facts, fell short of arriving at the truth.

Mr. Templeton, in the 1st volume of the Transactions of the Entomological Society, describes a Crustacean of the same genus which he observed likewise to dwell within a tube, and which he named *Cerapus abditus*.

Alluding to another species of this genus, Mr. Stimpson says, in his ‘Marine Invertebrata of Grand Manan,’ “The *Cerapus rubricornis* inhabits flexible tubes, of sizes corresponding to those of the individuals, composed of fine mud and some animal cement by which it is agglutinated. These tubes are generally adherent for about one-half their length, and closed below. They are usually found in large groups, attached to submarine objects and to each other. The animals are very active, protruding and retracting the anterior portion of their bodies, while their antennæ are in continual motion, lashing about in search of some object which might serve for food. It is very amusing to watch a colony of these animals, with their comical gestures in their disputes with each other, and their awkward celerity in regaining their respective tubes after having left them on temporary excursions. I have in no instance met with an individual transporting a free tube, as is said by Mr. Say to be the case with his *C. tubularis*. There can be no doubt but that the tube is fabricated by the animal; and this is not without precedent in the Crustacea, for I have often met with examples of *Pagurus* which had enlarged their borrowed shells by additions to their apertures*. From what I have seen in such species of *Corophiidae* as have fallen under my observation, I am inclined to think that most of the members of that family form more or less permanent tubes under certain circumstances. The *Unciola*, when kept in captivity, will frequently retire to some corner, and collect the sand around it by some glutinous substance so as to form a cavity, in which it will often remain for some time; but it may

* These additions are the result of a sponge growing upon the shell, and not built by the Crab.—C. S. B.

be easily made to leave it, and will make another if it be destroyed. On the other hand, some of the other individuals in the same jar will make no tubes; and often, at low water, they may be seen swimming about, perfectly free. The same is true of some of the other species of the family here mentioned, and of many species whose habits I had opportunities of observing in the harbour of Charleston, S.C., in the winter of 1851-52."

Kröyer, in his great work on 'Scandinavia,' &c., figures a previously undescribed Crustacean of the same order under the name of *Siphonocetus typicus* (Pl. VIII. fig. 1), which he found to inhabit small cases (not unlike those made by the Caddis-worm), built of small pebbles, sand, &c. Beyond these facts, I am not aware of any observations being published upon this curious subject.

Some years since, before I gave much attention to the subject, I had in a glass case a few Amphipoda in sea-water, with a little weed. After a short time, an hour or two, I was surprised to find that one of these small creatures had managed to bend round a portion of a leaf of green *Ulva* upon itself, and cement the same into a tube-like case, in which it lived, putting out its head and antennæ only; upon being disturbed at one extremity, it would quickly turn within its abode, and protrude its head at the other. I thought it curious at the time, but pursued it no farther, until more recent and longer-extended opportunities showed me that these were by no means isolated instances among Crustacea, but that a large and well-marked group enjoy this power; and that this group is again capable of being divided,—one division being distinguished by the construction of tubes open (occasionally?) at each end, the other by cases bearing a closer resemblance to nests, irregular in form, short, and open only at one extremity.

The animals which construct these two kinds of abodes possess an external structure that distinctly separates them from one another, and both again are distinguishable from the burrowers, or those which dwell in abodes that they have made by excavating channels in clay, mud, or wood.

Together these three groups form the family *Domicola* among the Amphipods, but separately they represent distinct sub-families, the value of which rests upon the structure of the animal composing each.

It is upon a clear appreciation of this structure that the genus *Amphitoë* has been removed from the position that has generally been assigned to it by authors, viz. near to *Gammarus*, and placed among the *Podocerides*.

When engaged in making observations for the "Report on the British Amphipoda" for the British Association, I kept in a glass

case several specimens of *Amphitoë rubricata* which I dredged up at the east end of the Plymouth Breakwater. These varied in their ages, from the very young to the well-advanced adult. In the small tank they soon separated themselves, and remained at rest in the same place. In these places I found that they shortly constructed for themselves nests which appeared to have been formed partly of foreign materials and partly secreted by the animal. A small area around each lair was swept clean, as if, in building, the animal procured all the material within its reach. And it is highly probable that the quantity of secreted matter is regulated by the greater or less amount of building material at hand. We know, in the Spider, that after constructing one or two webs, its power becomes exhausted. It is therefore desirable that they should economize this capability as much as possible. The *Amphitoë* generally seek out well-sheltered crevices at the roots of the great *Laminaria* (Pl. VIII. fig. 5), under stones and other objects that break the wash of the sea, and there construct abodes for themselves, by scratching together any available material within reach, and uniting it into a mass by a substance which they secrete.

If we take one of these small nests, and place it under a microscope, we find that it consists, independently of the collected material, of a quantity of fine threads, closely woven and knit together, crossing each other in the utmost confusion; and here and there are seen loops formed by a single thread being doubled and spirally twisted upon itself (Pl. VIII. fig. 5 a).

Mr. Thompson of Belfast has recorded having taken the common shore *Amphitoë* (*A. littorina*) in a nest; this I have seen, but have had no opportunity of examining its minute structure. It appeared to be more membranous than that of *A. rubricata*, and to be constructed without any foreign materials*.

The *Podocerus* is the next genus with which we are acquainted as possessing this power. A summer or two since, Mr. Howard Stewart brought me a small bunch of *Laomedea*, in the branches of which a colony of *P. pulchellus* had taken up their abode. The nests in this batch assumed a more decided form than those of any other species that I have seen. The form of the nest was narrow at the lower extremity and broad at the upper, at which end, moreover, was an opening into the nest. The top was covered, dome-shaped, except that it somewhat overhung on the side over the entrance to the nest, giving a curved appearance

* Since the above was written, I have received, among other Crustacea, a specimen of *Amphitoë littorina* and its case from Professor Kinahan, of Dublin. This was constructed of bits of weed, sand, &c., bound together by fine threads, similar to that of *A. rubricata*. I could perceive no spiral loops as shown in Pl. VIII. fig. 5 a.

to the structure, somewhat resembling a pear. Many of the nests were in what appeared to be an unfinished state. If so, they were constructed bit by bit, commencing from the smaller extremities, which were attached to the stems of the zoophyte. One side appeared to be so closely built-in with that on which it rested, as to render them very secure and strongly fixed.

Another species of this same genus* has been sent to me by Mr. Gosse from Ilfracombe and Tenby, together with the abodes constructed by it. Those found at Ilfracombe were attached to a leaf of green *Ulva*. They were chiefly gathered about the roots of the plant, but some few were constructed further up. The specimen from Tenby had the nests thickly clustered around the base, and were gradually progressing up the stem of an old *Tubularia*.

These nests, when examined under the microscope, appear to be composed of grains of fine mud cemented by some glutinous material that the animal secretes.

Mr. Alder kindly sent me a specimen that he had dredged; it consisted of small mud-tubes, about a quarter (or little more) of an inch in length, four of which were slenderly attached, at one extremity only, to a bit of *Antennularia*. Examination proved them to contain a species of *Siphonocetus* (Pl. VIII. fig. 2). Unlike Kröyer's species, the tubes of this were formed of mud, laid on, layer after layer, in successive rings, giving a somewhat annular appearance to the structure.

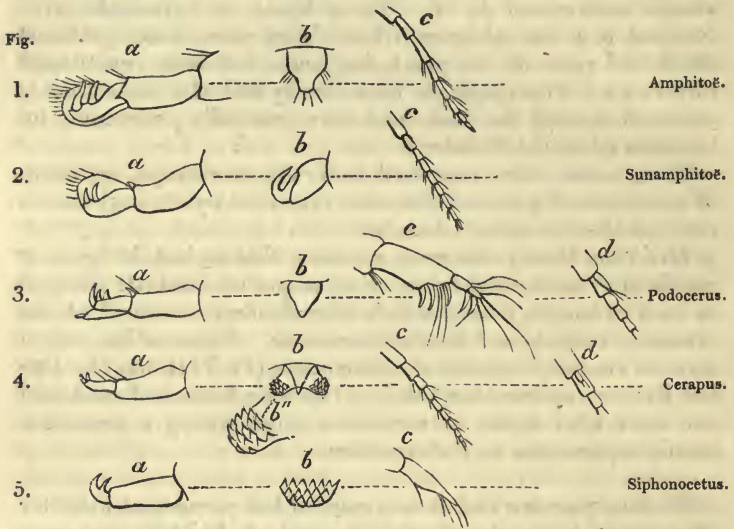
We here perceive that it is a more or less permanent habit for the species of several well-marked genera to build by their own exertions abodes in which they dwell. It is only natural to suppose that, having a common instinct, however varied their general form may be, they must in some parts of their structure possess some features common to the whole. It is upon the force of this argument that this group is separated from others to which in their general form they offer a striking resemblance. Upon the importance of these characters respectively rests the strength of the subfamily *Podocerides* in a natural classification, as distinct from *Corophiides*; for no philosophic naturalist could allow a group to be made if the habit were the only resemblance between species, since an apparent eccentricity (of which this class affords abundant examples) must disturb the arrangement.

Without examining the whole of the generic characters, we shall, I think, be able to exhibit certain well-marked resemblances

* I am inclined to think it is an undescribed species: it more nearly resembles *Podocerus* (*Cerapus*) *fucicola* of Stimpson than either of the other species.

that fully warrant the classification of *Amphitoë*, *Sunamphitoë*, *Podocerus*, *Cerapus*, and *Siphonocetus* into a subfamily.

The most important parts by which classification can be carried out are the appendages at each extremity,—the antennæ and the posterior pleopoda. The gnathopoda also are important; but they frequently differ in the sexes, and a great variety in their formation is compatible with the integrity of a genus.



In *Amphitoë* the upper antenna has no complementary appendage; in the lower antenna, the flagellum (fig. 1 c) terminates simply; the posterior pleopod (fig. 1 a) is double-branched, one branch being furnished with two or more short, stout spines planted in such a position as to be directed forwards and serve the purpose of hooks; the other is developed in the form of a scale or plate, more or less fringed with fine hairs. The telson (fig. 1 b) is a simple plate narrowing posteriorly to an apex.

The genus *Sunamphitoë* is very near to that of *Amphitoë*, the great difference being that the telson of *Sunamphitoë* is developed into a single well-formed and powerful hook (fig. 2 b).

In *Podocerus* the upper antenna has a rudimentary secondary appendage (fig. 3 d). The flagellum of the lower antenna (c) consists of only a few articulations, and the last two are furnished with two or more short, stout, curved, hook-like spines, and a few strong hairs. The posterior pleopod (fig. 3 a) is double-branched; the outer branch with two or more hook-like spines,

the inner more styliform than in *Amphitoë*, and tipped with one or more short spines. The telson (fig. 3 *b*) is simple and pointed as in *Amphitoë*.

In *Cerapus* the upper antenna has a very rudimentary secondary appendage (fig. 4 *d*). The lower antenna has a simple flagellum (*c*). The posterior pleopod (*a*) is single-branched, and terminates in two imperfect hooks. The telson (*b*) is double-lobed, each lobe being covered with a number of short points directed anteriorly.

In *Siphonocetus* the upper antenna is without any secondary appendage; the lower has the flagellum reduced to two or three stout articulations (fig. 5 *c*). The posterior pleopod (*a*) is single-branched, the terminal joint being very short, and furnished with two well-formed, powerful hooks. The telson (*b*) is single(?)-lobed, and furnished with a number of short points directed anteriorly.

If we compare the relative parts, we find that the upper antennæ of *Amphitoë*, *Sunamphitoë*, and *Siphonocetus* are without secondary appendages; while those of *Podocerus* and *Cerapus* have them in rudimentary (microscopic) forms. The lower antennæ of *Amphitoë*, *Sunamphitoë*, and *Cerapus* alike possess simple flagella; while those of *Podocerus* and *Siphonocetus* have the flagella reduced to two or three strong articulations furnished with stout hairs, some of which in *Podocerus* are reduced to short, curved spines. The posterior pleopod scarcely differs in *Amphitoë*, *Sunamphitoë*, and *Podocerus*; and in *Cerapus* it differs from *Siphonocetus* in the absence of the squamiform branch. The telson in *Amphitoë* resembles that of *Podocerus*, while the telson of *Cerapus** differs from that of *Siphonocetus* in the former being double- and the latter being single-lobed; whereas the telson of *Sunamphitoë* is peculiar to itself.

The hairs with which many of these Crustacea are furnished evidently constitute a peculiar feature in this small group. Losing their soft and pliant form, they assume that of short points, strong spinous processes, and curved hooks. These changes are brought about to serve some efficient purpose in the œconomy of the animals. The hooks are placed on the posterior appendages of the several genera, and are so directed that the animals can pull themselves backwards; and when they are

* There can be little doubt that *Erichthoneus* of Edwards is synonymous with *Cerapus* of Say, and, according to Dana's figures, the genus *Pyctilus* also. The female of *Cerapus* bears a much nearer resemblance to *Podocerus* than to its male,—a circumstance that had led me to describe a female *Cerapus*, in the 'Synopsis of the British Edriophthalma,' as *Podocerus punctatus* (having never seen the male); it agrees closely with Leach's specimen of *Jassa punctata* in the British Museum.

situated upon the antennæ, they are so arranged that they can pull themselves forwards. The antennæ in *Podocerus* and *Cerapus* are, from their structure, evidently used as organs of prehension; and useful they are, no doubt, in their excursions through the tangled maze of numerous zoophytes and forests of weed that hang around the floating masses where they mostly love to dwell.

There can be little doubt, I think, that the hooks at the posterior extremities of the animals enable them to retire into their cases, and to turn round when they are within, which they do with a celerity that is noticeable.

Those Amphipoda that inhabit hollows which they make by burrowing into wood, clay, &c., such as *Corophium* and its near allies, exhibit a marked distinction in their formation: they penetrate by the aid of their anterior limbs. Thus we see the inferior antennæ developed into powerful (sometimes monstrous) organs, and used for breaking down the mud into which they excavate, for the purpose, it is supposed, of feeding upon the worms that dwell within it. In proportion to the power given to the anterior part, by so much does the posterior appear to be enfeebled. The posterior pleopoda in *Corophium* and *Uniola* lose their importance, and in *Cyrtophium* become rudimentary.

The distinct characters exhibited in the structure of this latter subfamily (*Corophiides*) are of such importance, that it is impossible to class the animals in the same group with *Podocerus*, although there are certain similar features in their habits which have induced authors to place them nearer to each other. Habit alone cannot be trusted to define the position of an animal in relation to its connexion with others of its class.

Of this we have examples in *Chelura* and *Phronima*. The former, like *Corophium*, burrows for food, but instead of penetrating into mud, eats its way into submarine wood; but its structure is so anomalous when compared with others of its class, that every naturalist has thought it desirable to place it in a family by itself.

With regard to *Phronima* our knowledge is small: its habit is that of an inhabitant of the gill-cavities of some one or more species of *Medusa*; but in the Collection of the British Museum entrusted to my care for examination is a very curious case that was sent home from Naples by S. P. Pratt, Esq., as being the one in which the animal was taken (Pl. VIII. fig. 6). The structure is thick, fleshy, semitransparent, and studded over the surface and round the two orifices—one of which is smaller than the other—with numerous white excrescences. Examination with the microscope (fig. 6 a) shows the substance to be pervaded by bundles

